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(54) Sealing optoelectronic packages

(57) An optoelectronic package, containing a semiconductor device, com-

prises a metal housing 1 and a transparent glass lid 4. The lid is sealed to the housing by means of a two part seal, which consists of an inner seal of a material such as epoxy resin 11 and an outer seal of solder material 10. The solder material provides a true hermetic seal to prevent ingress of contamination to the semiconductor body, whilst the epoxy material prevents fluxes given off by the soldering operation from reaching the interior of the housing. Conveniently, preforms of both solder material 10 and epoxy material 11 are carried by a common carrier 9 comprising a mesh of stainless steel wires. The assembly is heated and compressed to cure the epoxy resin, the spacing between lid 4 and housing 1 being determined by the thickness of the solder preform. The solder is then melted to complete the seal preferably using localised heating.

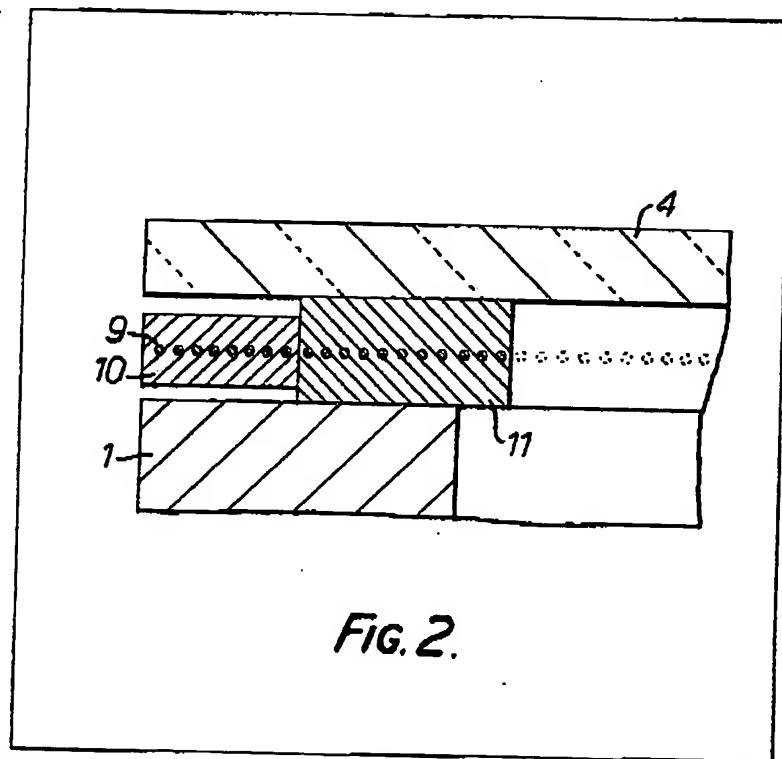
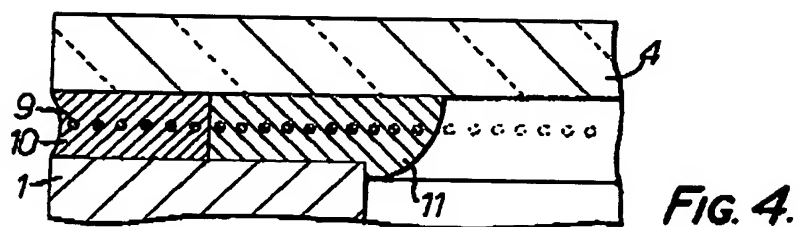
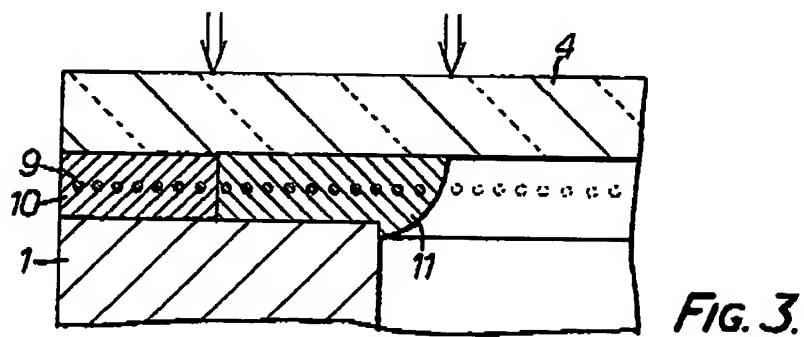
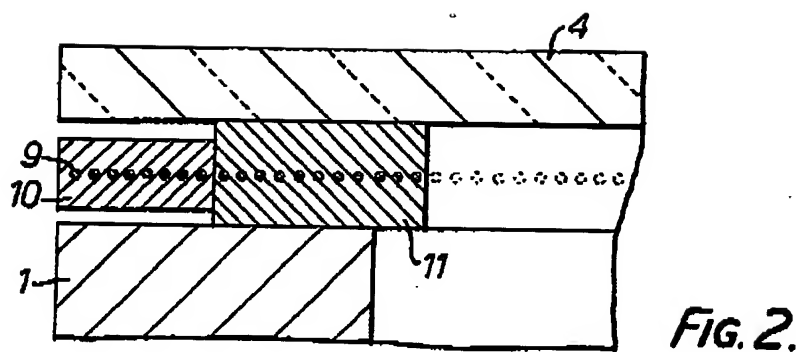
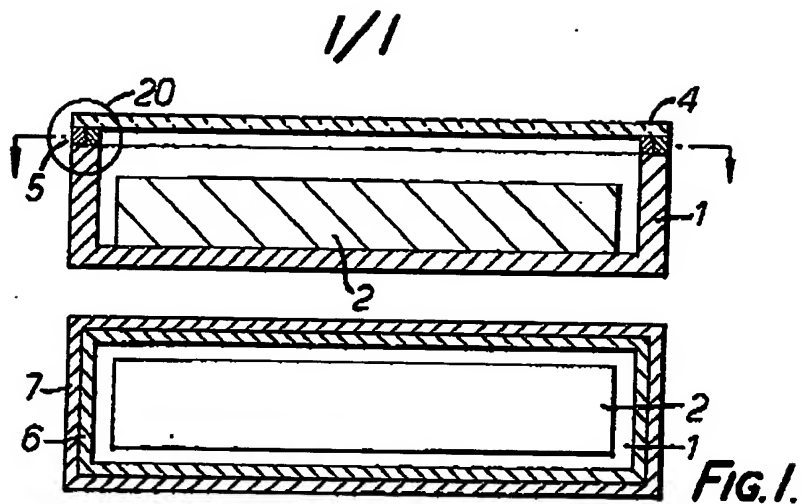


FIG. 2.

The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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SPECIFICATION

Optoelectronic package

5 This invention relates to optoelectronic packages, that is to say, to packaged electronic devices which respond to or emit light. Optoelectronic devices, such as light emitting diode displays and solid state imaging camera devices, require the provision of a transparent window, usually formed of high quality glass which is sealed to the device's package. The seal is generally required to be of a hermetic nature, so that the ingress of contamination is not permitted. Contamination in the form of water vapour, for example, can cause corrosion and/or performance degradation of active devices used within the package. It has been proposed to hermetically seal a package by using a metal cover which is welded or soldered to a housing, but it is difficult to obtain a good seal to glass without the use of fluxes which could introduce contamination problems if allowed to come into contact with the active devices. Alternative sealing materials such as epoxy resins, plastics or silicones do not provide a truly hermetic seal.

25 According to this invention, an optoelectronic package includes a housing containing an electronic device and which is sealed by means of a lid having an optically transmissive window portion, the lid being sealed to the housing by an outer seal comprising a solder material, and by an inner seal comprising a barrier material which acts as a barrier to vapour given off during the formation of the outer seal.

The solder material is preferably a conventional soft solder, but it may be hard solder - when a hard solder is used the process is often called brazing.

The barrier material is preferably an epoxy material, but a silicone or other plastics material could be used.

40 The lid may comprise a strong frame made of a material such as metal within which a window is hermetically sealed before the lid is secured to the housing, but preferably the entire lid comprises an optically transmissive window which is itself sealed to the housing.

Although the epoxy material does not itself provide a truly hermetic seal, it provides protection to the interior of the housing against any contaminating vapours given off when the outer seal is formed. The solder material is such as to constitute a truly hermetic barrier which prevents ingress of contamination.

The invention is further described by way of example with reference to the accompanying drawings, in which

Figure 1 shows sectional views through a package in accordance with the invention and

Figures 2, 3 and 4 illustrate different stages in the manufacture of a sealed package.

60 Referring to Figures 1 and 2, a housing 1 which may be metal, or ceramic with a brazed metal seal ring, is in the form of an open tray having an active semiconductor body 2 mounted rigidly on a floor surface. The body 2 comprises one or more semiconductor devices of the kind which respond to light

or which emit light, via a transparent window which is constituted by a lid 4. The body 2 may typically comprise a solid state imaging camera of the kind utilising an array of charge coupled devices. The surface of such a device is extremely sensitive to contamination and yet it must receive an optically perfect and undistorted image. For this reason, the lid 4 is formed of high quality transparent glass. In order to seal the body 2 from its surroundings and to provide it with the necessary degree of protection, the lid 4 is sealed to the upper edges of the walls of the housing 1 by a two part seal 5 consisting of an inner seal 6 of epoxy resin material and an outer seal portion 7 of solder material.

80 As is well known, solder material can be used to provide an excellent hermetic seal, which prevents contamination even in the form of vapour from passing through it. However, the fluxes necessary to achieve an excellent and reliable solder bond give off undesirable and corrosive vapours, which can adversely affect the electrical and optical performance of the active body 2. The inner seal 6 which is formed of an epoxy resin provides an adequate barrier which prevents these corrosive flux vapours from reaching the interior of the housing 1.

The process by means of which the two part seal is used to firmly bond the high quality glass lid 4 to the housing 1 is described with reference to Figures 2, 3 and 4.

95 The two part seal is supported by a preformed carrier 9 constituted by a fine mesh, typically of stainless steel wires or glass fibres. The outer portion of the carrier 9 supports a preformed body of solder material 10 of substantially uniform thickness. The inner portion of the carrier 9 carries a preform of uncured epoxy resin 11 which is also of substantially uniform thickness, but which is slightly thicker than the solder. The carrier 9, with the solder material and the uncured epoxy resin in situ, is placed on the upper edges of the housing 1, and then the glass lid 4 laid over it as is illustrated in Figure 2. Figure 2 shows, to a larger scale, the detail of the region 20 of Figure 1. Mechanical pressure is subsequently applied to the lid 4 so as to press it towards the housing 1, whilst the whole assembly is heated to the softening temperature of the epoxy resin, so that the applied pressure compresses the epoxy resin until the separation between the housing 1 and the glass lid 4 is defined by the thickness of the solder 10. This stage is illustrated in Figure 3, and subsequently the epoxy resin is cured to render it firm and stable with care being taken not to raise the temperature of the solder to its softening point during this process. Conventional techniques such as vacuum bake out can be used to remove undesirable gases and impurities from the interior of the sealed housing, which can subsequently be filled with an inert gas if necessary.

When the epoxy resin 11 is fully cured, the temperature of the solder 10 is raised to its melting point so that the solder flows and forms a mechanical seal to both the glass lid 4 and the housing 1. If the semiconductor body would be adversely affected by the application of excessive heat, it may be desirable to use localised heat to raise the temperature of the

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solder to its melting point. For example, the solder can be heated by means of a hot air jet or by a laser beam which follows the periphery of the package. Localised heating can also advantageously be used to reduce the overall thermal stress which might be introduced into the package. When the solder cools it forms a firm bond as is illustrated in Figure 4.

It is generally necessary to use fluxes to effect a firm solder bond, and contamination by the flux vapours which can be given off is prevented by the presence of the epoxy resin. Conveniently, the solder in the preform contains its own flux, which renders unnecessary the need to apply flux separately in liquid form during the manufacture stage illustrated in Figure 4.

The use of the external solder seal has the further advantage that the semiconductor body 2 can now easily be protected from any external radio frequency electric field. In this case, it is necessary to also provide an electrically conductive coating on the inner or outer surface of the glass lid 4 and to electrically connect this coating to the solder material 10. It is assumed that the metal housing 1 has a good electrical conductivity and is, of course, formed of material to which solder readily adheres. In order to protect the conductive coating, and to facilitate electronic contact with the solder, it is preferably positioned on the underside of the lid 4. It is possible to produce an electrically conductive coating by conventional means so that it is quite transparent to light, and so does not degrade the optical performance of the semiconductor body 2.

CLAIMS

1. An optoelectronic package including a housing containing an electronic device and which is sealed by means of a lid having an optically transmissive window portion, the lid being sealed to the housing by an outer seal comprising a solder material, and by an inner seal comprising a barrier material which acts as a barrier to vapour given off during the formation of the outer seal.
2. A package as claimed in claim 1 and wherein the outer seal comprises a silicone or plastics material.
3. A package as claimed in claim 1 and wherein the outer seal comprises an epoxy material.
4. A package as claimed in claim 1, 2 or 3 and wherein the electronic device is formed in a body of semiconductor material.
5. A package as claimed in any of the preceding claims and wherein the entire lid comprises an optically transmissive window which is itself sealed to the housing.
6. A package as claimed in any of the preceding claims and wherein the barrier material and the solder material are supported by a common carrier.
7. A package as claimed in claim 6 and wherein said carrier comprises a stainless steel wire or glass fibre mesh.
8. A method of sealing an optoelectronic package by sealing an optically transmissive lid to a housing, including the steps of positioning between the lid and the housing a two part seal consisting of

an outer seal comprising a preform of solder material and an inner seal comprising a barrier material which acts as a barrier to vapour given off during the formation of the outer seal, and subsequently heating the solder material to form a bond with the lid and the housing.

9. A method as claimed in claim 8 and wherein the barrier material is epoxy material, and wherein prior to heating the solder material the epoxy material is used to form a bond with the lid and the housing.

10. A method as claimed in claim 9 and wherein the preform of epoxy material and the preform of solder material are contiguous with each other and supported by a common carrier.

11. A method as claimed in claim 10 and wherein the preform of epoxy material is of greater thickness than the preform of solder material.

12. A method as claimed in claim 11 and wherein the epoxy material is heated to its softening temperature, and the lid and the housing are urged together so as to deform the epoxy material and reduce its thickness until the spacing between the lid and the housing is defined by the thickness of the preform of solder material.

13. A method as claimed in claim 12 and wherein after the epoxy material is cured, the solder material is locally heated so as to form a hermetic seal between the lid and the housing.

14. An optoelectronic package substantially as illustrated in and described with reference to Figure 1 of the accompanying drawing.

15. A method of sealing an optoelectronic package substantially as illustrated in and described with reference to Figures 2, 3 and 4 of the accompanying drawing.

New claims filed on 10 Mar 1983
New claims:-

16. A method of sealing an optoelectronic package by sealing an optically transmissive lid to a housing, including the steps of positioning between the lid and the housing a two part seal consisting of an outer seal comprising a preform of solder material and an inner seal comprising a deformable barrier material having an initial thickness greater than said preform; urging said lid and said housing together so as to deform said barrier material and reduce its thickness until the spacing between the lid and the housing is defined by the thickness of the preform of solder material; and subsequently heating the solder material to form a bond with the lid and the housing, the barrier material acting as a barrier to vapour given off by the heated solder material.

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